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Abstract: Whooping cranes (*Grus americana*) of the Aransas-Wood Buffalo Population migrate 4,000 km twice each year between their nesting grounds in northern Canada and their wintering grounds on the Texas Gulf Coast. During migration, whooping cranes must land at suitable ponds or wetlands to feed or rest. The Whooping Crane Recovery Plan calls for the protection and management of whooping crane stopover locations within the migration corridor. While major stopover areas have been protected, many other smaller sites remain to be identified. Moreover, the Recovery Plan offers no specific entity to protect and manage the latter. To address these gaps in information and activity, Friends of the Wild Whoopers engaged with large land-holding entities (military bases and Indian Reservations) within the migration corridor to share information about whooping cranes and their habitat needs and identify suitable stopover sites that could be protected and managed for cranes. This cooperative effort identified up to 177 wetlands/ponds as potential stopover sites on 14 military bases in Kansas, Oklahoma, and Texas, and as many as 1,275 on 6 Indian Reservations in North and South Dakota, with commitments to manage the habitats as resources allow.

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Key words: Aransas-Wood Buffalo population, Great Plains, *Grus americana*, Indian Reservation, military base, pond, stopover habitat, wetlands, whooping crane.

There is only 1 natural wild, self-sustaining migratory population of whooping cranes (*Grus americana*) remaining, the Aransas-Wood Buffalo Population (AWBP). This population nests and raises its young in Canada's Wood Buffalo National Park (April-October) and winters on or near Aransas National Wildlife Refuge (NWR), Texas (October-April). The birds migrate 4,000 km 2 times each year between the nesting and wintering areas. During migration, whooping cranes must land at any suitable pond or wetland when they become tired, when severe weather occurs, or before night time. These stopover sites are important because they provide cranes with foraging habitat and safe nocturnal roosts. A recent on-the-ground study of 504 roost sites identified by global positioning system data collected from AWBP whooping cranes fitted with platform transmitting terminals categorized the stopover habitats in the Great Plains portion of the migration corridor as follows: 50% emergent wetlands (typically small- to medium-sized wetlands with herbaceous vegetation), 25% lacustrine wetlands (e.g., lakes, reservoirs, impoundments), 20% riverine, and 5% dryland ("sites without discernible surface water" but rarely used for more than 1 night) (Pearse et al. 2017). The same study also categorized 83 day-use sites as dryland sites (54%), wetlands (45%), and riverine (1%). The day-use dryland sites were mostly agricultural fields (69%), followed by upland grasslands (22%) and lowland grasslands (9%) (Pearse et al. 2017). Whooping cranes were not directly observed at these dryland locations, but presumably the open fields were used for foraging and resting.

Since 1941, the AWBP has increased from 15 birds to an estimated 431 as of winter 2016-17 (Butler and Harrell 2017). Despite the increasing population trend, the whooping cranes of the AWBP remain defenseless against 2 depredations: habitat destruction and gunshot. During the 200-year period from 1780 to 1980, wetland acreage in the whooping crane migration corridor within the United States declined by more than 6 million ha (Table 1; also see Dahl 2000). The full extent of threats to and loss of stopover habitats within the migration corridor are difficult to quantify but real. These habitats are being diminished and degraded due to a variety of factors, including intensified management on agricultural lands (Matson et al. 1997), construction of wind energy facilities and power lines (Pearse et al. 2016), and wetland drainage and reduction in river flows (Samson et al. 2004). Changes in agricultural programs may further reduce the stopover habitats available for whooping cranes (Stehn and Prieto 2010), as may the effects of climate change (Chavez-Ramirez and Wehtje 2012).

The Whooping Crane Recovery Plan (Canadian Wildlife Service and U.S. Fish and Wildlife Service 2005) includes numerous references that describe various wetlands used as stopover sites. Important

Table 1. Loss of wetland area in the United States portion of the whooping crane migratory corridor between 1780 and 1980. Data are from Dahl (1990).

State	1780 area (ha)	1980 area (ha)	Lost area (ha)	Percent loss
North Dakota	1,944,089	1,007,667	936,422	49
South Dakota	1,092,651	809,371	283,280	35
Nebraska	1,177,838	771,290	593,452	35
Kansas	340,341	176,200	164,141	48
Oklahoma	1,150,359	384,330	766,029	67
Texas	6,474,849	3,080634	3,394,215	52
Total	12,180,127	7,038,864	6,137,539	49

migration stopover sites in the United States include Cheyenne Bottoms State Waterfowl Management Area and Quivira NWR, Kansas; the Platte River bottoms between Lexington and Denman, Nebraska; and Salt Plains NWR, Oklahoma. These large sites have been designated as *critical habitat* for conservation of the species (U.S. Department of the Interior 2017; *critical habitat* is defined in the U.S. Endangered Species Act as habitat that contains physical or biological features essential to the conservation of the species, and which may require special management considerations or protection [43 FR 20938-942]). Other stopover areas have also been identified, both large (e.g., Audubon NWR and Long Lake NWR in North Dakota; Austin and Richert, 2001) and small (e.g., Pearse et al. 2017). Moreover, whooping cranes are not site-specific each migration and rarely use the same wetland basins year to year (Pearson et al. 2018). For these reasons, Friends of the Wild Whoopers (FOTWW) emphasizes that numerous other smaller stopover sites are also essential to ensure diverse opportunities for potential stopover use along the migration corridor.

The Whooping Crane Recovery Plan calls for the protection of existing wetlands as whooping crane stopover areas and the enhancement of those wetlands that have been degraded by woody plant encroachment, silting, and/or draining within the migratory corridor. An outline of recovery actions to achieve objectives is explained in the Recovery Plan (Canadian Wildlife Service and U.S. Fish and Wildlife Service 2005:41-42). These actions include identifying, protecting, managing, and creating habitat. Identifying essential habitats and ensuring long-term protection of migration stopover sites are specific tasks. The objectives include "Complete measurement of availability of migration stopover habitat and monitor changes over time." More specifically, the Recovery Plan (section 1.5.3.2.) spells out the need to "Ensure long-term protection of migration stopover sites. Work with landowners to ensure migration habitat remains suitable for cranes. Pursue stewardship agreements and conservation easements when needed, focusing on providing wetland mosaics" (p. 49). However, the Recovery Plan offered no specific entity to protect and manage potential stopover sites. FOTWW emphasizes that a realistic action plan should be developed to name specific agencies to protect and manage existing stopover wetlands and to create new ones. Within the United States portion of the migratory corridor, FOTWW could find no ongoing concerted effort that focuses on protection or enhancement of many potential stopover areas. Private conservation groups and government agencies have played a significant role in protecting wetlands used by whooping cranes, waterfowl, and many other wildlife species throughout the migration corridor. For example, funds from the sale of Duck Stamps have helped protect over 2.4 million ha of wetlands (National Wildlife Refuge Association 2017), but many of those are managed for waterfowl in ways that may not be suitable for cranes (e.g., presence of tall emergent vegetation around the perimeter or deeper water that would deter cranes from roosting). To address this gap in information and activity, FOTWW initiated a survey of entities with large land holdings that could possibly provide additional stopover areas.

The criteria used by FOTWW to identify suitable whooping crane stopover habitat were as follows:

- Lake, pond, wetland at least 0.12 ha.
- Lake, pond, wetland with a shallow area 12-25 cm deep for roosting.
- Glide path (for whooping cranes to land near the water body) is clear of obstructions (e.g., power lines).
- No thick vegetation or trees near the landing site: open landscapes allow whooping cranes to easily locate the ponds and provide for ready observation of any predator threats.
- Gradual or gentle slope into the water where it is shallow.
- Little or no emergent/submerged vegetation in the roost area.
- Extensive horizontal visibility from the roost site.
- At least 275 m from human development or disturbance.

The first 2 phases of the project evaluated potential

stopover habitat on U.S. military bases and Indian Reservations within the corridor. Initial contacts were made with respective leaders within each entity as described below, and positive responses were followed up with on-site visits.

Military Bases

The first phase involved U.S. military bases within the states of North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. Leaders in the Department of Defense Partners in Flight (DODPIF) were contacted to elicit their support and obtain names of biological personnel on 41 military installations within the migration corridor. Thirty-five installations responded and provided information about their base size, habitats, and compatibility with a potential whooping crane stopover habitat project. Based on information obtained during telephone and email contacts, FOTTW eliminated 21 bases because they were too small or had no suitable habitat, while some air bases feared potential bird collisions with aircraft. The remaining 14 bases met the habitat conditions needed for our project and approved us to visit. These included Fort Hood, Texas; Camp Swift, Texas Army National Guard (TXARNG), Texas; Camp Bowie, TXARNG, Texas; Camp Maxey, TXARNG, Texas; Wallisville Lake, U.S. Army Corps of Engineers (COE), Texas; Addicks Reservoir, COE, Texas; Barker Reservoirs, COE, Texas; Fort Sill, Oklahoma; Tinker AFB, Oklahoma; McAlester Army Ammunition Plant, Oklahoma; Fort Riley, Kansas; Kansas Training Center, Kansas Army National Guard, Kansas; and Forbes Field Kansas Air National Guard, Kansas.

The Gulf Coast Bird Observatory (GCBO) partnered with us on the military project phase. We made field trips to the military bases from July 2015 to September 2016. FOTWW and GCBO personnel discussed whooping crane biology, habitat management needs, and specific management practices needed with military wildlife biologists during the field trips. Habitats were evaluated on the 14 bases following the criteria described above. We developed detailed management recommendations for each base to protect, improve, or develop potential whooping crane stopover habitats and provided detailed reports for each base explaining our management recommendations. Copies were provided to all personnel involved.

We identified 102 wetlands that met our criteria for stopover habitats on the 14 bases. Seventy-six percent needed minor, inexpensive management to become suitable stopover habitats. Importantly, we identified approximately 75 additional wetlands that could also be managed and made into adequate stopover habitat. Military officials were encouraged to protect and manage the identified wetlands. All military personnel advised that they intended to implement our recommendations over time as funding and time permits. FOTWW and GCBO have no authority to require that our recommendations be implemented. Importantly, however, the military has laws and regulations that it must follow. For example, in accordance with the Endangered Species Act of 1973, as amended, the Army must assist in recovery of all listed threatened and endangered species and their habitats under the Army's land management authority. Also, the Migratory Bird Treaty Act (16 U.S.C.703-712) requires protection of shared migratory bird resources with 4 other nations. Importantly, the Sikes Improvement Act of 1977 (16 U.S.C.670) requires the Secretary of Defense to carry out a program to provide for the conservation and rehabilitation of natural resources on lands used

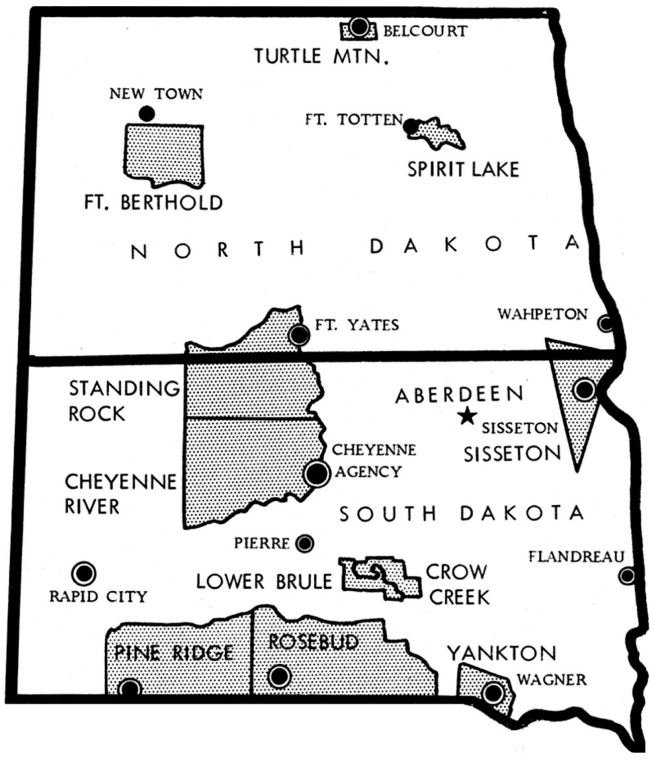

Figure 1. Locations of Indian Reservations (stippled) in North and South Dakota.

for military mission activities. Based on FOTWW and GCBO observations, the military personnel with whom we met are using all these legal authorities to properly manage lands in a manner beneficial to many species of wildlife, including whooping cranes. Since we completed the military phase, about half of the biologists have contacted FOTWW for additional discussions and advised that they were accomplishing our recommendations over time.

In addition, more biological land managers are now interested in helping endangered whooping cranes. Furthermore, our efforts have begun to address habitat-conservation objectives described in the Recovery Plan, which include identifying, protecting, managing, and creating stopover habitat.

Indian Reservations

The second phase involved stopover habitat opportunities on Indian Reservations within the corridor. After completing the project on military lands, FOTWW contacted the Great Plains Region Indian Headquarters to explain our whooping crane stopover habitat project. We decided to focus on 7 reservations in North Dakota and South Dakota that collectively have approximately 2.6 million ha of land. There are an estimated 1,000 permitted range units and 6,000 farm/pasture leases on the 7 reservations. The headquarters reservation biologist (each reservation has a biologist) advised that there are over 1,700 potential stopover wetlands on the reservations within the whooping crane migration corridor.

The regional headquarters endorsed our efforts and furnished us with contact information for natural resource personnel on individual reservations. Natural resource personnel were then contacted by telephone. FOTWW's project was described and resource personnel were provided an opportunity to ask questions. Visits were then made to each reservation during August 2016 through October 2016 to provide training to personnel on whooping crane migration and stopover habitat needs. Indian Reservations visited included Fort Berthold, Spirit Lake, and Standing

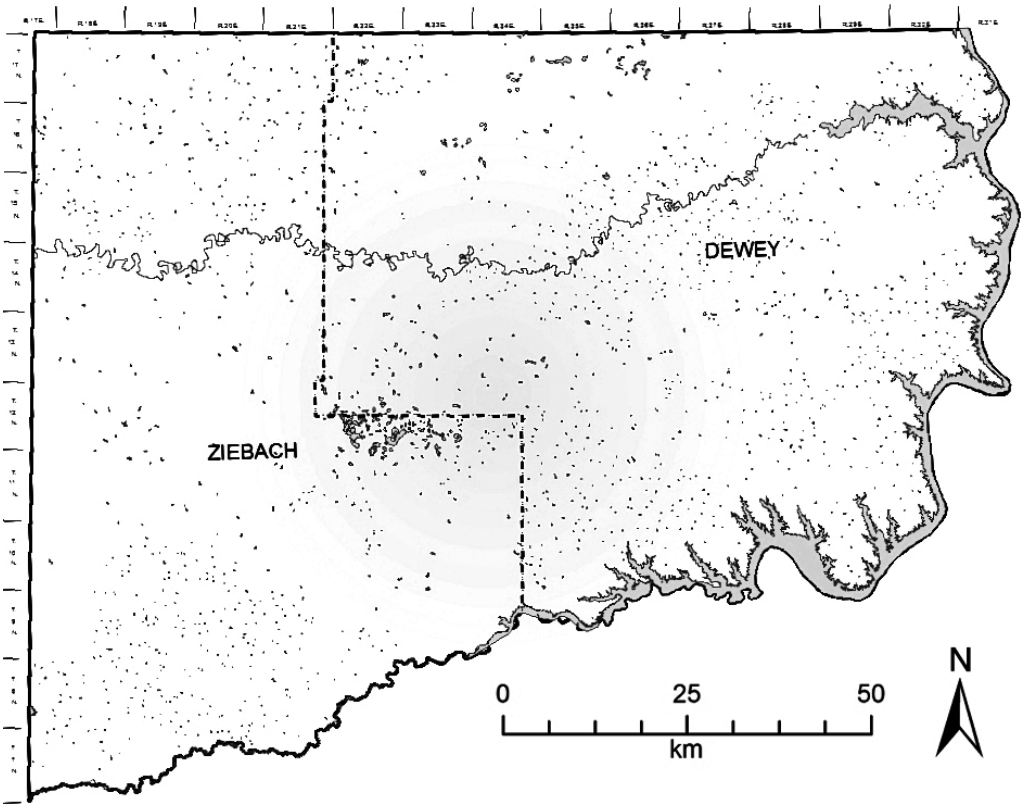

Figure 2. Cheyenne River Sioux Reservation, Ziebach and Dewey Counties, South Dakota, has 1,196 stock dams/ponds. They range in size from about 0.1 to 19.8 ha, with the average size being 0.92 ha. Each dot on the map represents a pond.

Figure 3. Pond with cattle grazing on Cheyenne River Sioux Reservation, South Dakota. Note that vegetation around portions of the shore is short (A) and cattail invasion (B) has been restricted due to livestock grazing. The shallow area (C) within the pond would provide suitable roosting sites for whooping cranes.

Rock, North Dakota; and Cheyenne River, Crow Creek, Lower Brule, and Rosebud, South Dakota (Fig. 1). As an example of reservation water resources, a map of the locations of stock dams/ponds on the Cheyenne River Sioux Reservation is shown in Figure 2.

Reservation personnel and FOTWW made detailed, on-the-ground assessments of potential stopover habitats following the criteria described earlier. During each of the field trips, we stopped at 15 to 25 wetlands. As with the military base visits, at the first several wetlands, FOTWW described the features that attract whooping cranes to select certain ponds as stopover habitats. Then, during the following stops, participants were asked to explain what features made each pond acceptable or not to the cranes. If a wetland did not have the required features, we discussed how it could be made acceptable. FOTTW was gratified by the interest of the personnel and their performance in conducting habitat suitability site evaluations for whooping crane stopover habitat.

Based on the field evaluations and accepted habitat criteria, reservation natural resource personnel estimated that approximately 75% of the 1,700 wetlands could provide good stopover habitat, although some may require management. That equates to about 1,275 wetlands. Based on the sample of wetlands that we personally observed, FOTWW has confidence that the estimate is correct.

Some of the stock ponds on the reservations are currently in excellent condition to serve as good whooping crane stopover sites. Some others could easily and inexpensively be developed into good habitats by cutting dense vegetation around the edge of the ponds. However, some stock ponds are not useful for whooping cranes because cattails (*Typha* spp.), bushes, and trees are currently thick along the shore areas. On these latter ponds, FOTWW recommends that they be managed for other wildlife species that prefer dense vegetative cover. Importantly, FOTWW contends that it is not necessary or desirable to modify or manage all ponds for whooping cranes, but rather to focus on a subset with the best ponds and surrounding landscape characteristics.

So, what did FOTWW accomplish on the Indian Reservations? As with the military bases, interest in whooping cranes by natural resource personnel was

significantly increased. Reservation personnel were encouraged to protect and manage hundreds of potential stopover wetlands, thus targeting some of the major unmet objectives described in the Recovery Plan.

Finally, during the field trips, FOTWW detected an activity of livestock that is potentially beneficial to whooping cranes. As noted above, whooping cranes do not use wetlands as stopover sites where tall, dense vegetation closely surrounds the pond shore, where predators may be lurking. Around some ponds, we observed that livestock had grazed and trampled the vegetation when reaching a shallow area where they can safely enter the pond's edge to obtain drinking water (Fig. 3). This resulted in unobstructed shore areas that would allow whooping cranes to use these ponds as stopover sites. Whooping cranes favor these same types of shallow areas with sparse vegetation to enter ponds to roost. We observed this phenomenon of vegetation trampling by livestock on numerous wetlands, especially in North and South Dakota. Thus, livestock pond water resources could incidentally provide additional suitable stopover habitat for whooping cranes.

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